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Cross-Institutional Pathway Guidance Chance or Extra Burden?

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Abstract. In this paper, we examine requirements, show potential user interfaces and describe a prototypical development for a Pathway Navigator App that guides the patient through healthcare episodes. Our use case is a fictional patient requiring surgery for a hip total endoprosthesis. Fundamental is the provision of appointment information and the option to contact the healthcare provider for rescheduling. This implied an architecture which was more complicated than expected. We realized an HL7 interface for appointment data from hospital information systems; no comparable standard was found for GP IT systems. The future Swiss Electronic Patient Dossier could enhance the integration of the Path App within a broader health-IT ecosystem.

Keywords. Clinical pathway, app development, medical informatics

1. Introduction

Clinical pathways have been promoted for healthcare since considerable time [1-4]. *A clinical pathway is a document describing the common process of a multidisciplinary treatment for a particular type of patient* [1]. Pathways were promoted in Australia (Sydney) [1,2], particularly, as an answer for cost control in view of the impact of diagnoses related group reimbursement, which leads to reduced inpatient stay and mandates faster diagnostic and therapeutic workup of the patient. Most of these efforts, however, define clinical pathways within a single institution [2,3,4].

Patient care, however, is often not limited to one institution, but rather a combined cross-sectorial effort where many caregivers in inpatient and outpatient segments have to cooperate for an optimized treatment. Our idea within a research project was to improve co-operation by supporting streamlined workflows [5].

The "Patient Navigator App" was planned as a mobile application accompanying the patient through all parts of his/her outpatient and inpatient care and rehabilitation using the hip total endoprosthesis (TEP) as a use case. Here, we describe the development process and discuss the challenges in implementing such application into practice.

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2. Methods

The Patient Navigator App was an essential part within the Swiss research project "Hospital of the Future". This project consisted of several stages. The overall use case was a fictional elderly multi-morbid patient requiring hip surgery and implantation of a hip TEP for advanced arthrosis. The first project stage delivered a vision for a digitally enhanced future of the Swiss healthcare system. The goal was to develop prototypical IT applications to demonstrate parts of this visionary process. Twenty-five partners including six Swiss hospitals, four major IT suppliers and eHealth Suisse, the coordinating body for the implementation of the Swiss eHealth environment, co-operated as active stakeholders [5]. A set of atomic work packages were defined and combined in student activities supported by our stakeholders. Results were implemented as prototypes in our comprehensive medical laboratory environment. Specifically, the Patient Navigator App was developed in four consecutive student activities.

2.1. Medical informatics seminar – analysis of the problem

In a first step, the information regarding clinical pathways for hip TEP was collected from literature and in discussions with stakeholders. The students identified options where IT could help to save time and make information on the patient available. Further, similar applications available on the market were identified and a first system architecture with required interfaces to clinical systems was developed. In a survey among potential users of the patient navigator app, requirements with respect to the application's functionalities as well as desired design components were collected, using a paper-based mockup of the application. In addition, the general use of mobile devices among elderly patients was investigated in this survey.

2.2. Clinical Apps for tablets – definition of required functionality and app interface

"Clinical Applications for tablets" is a competitive teaching format [6] where different project teams deal with the same task. Their task was to develop a visualization of the appointment data and to define functionalities. Three project teams were established to construct a first prototype of a Patient Navigator App. The groups were free to decide their architectural approach, their programming environment and their user interface design. Two groups used the Vaadin framework [7] for app development, the third group opted for Gluon [8].

2.3. Living Case – prototype development

"Living Cases" are courses with the goal to develop prototypes of IT-application [6]. Two students realized a prototype of the Patient Navigator App, comprising an app frontend for the patient, a PathApp server [9], a web interface for healthcare professionals to support scheduling and rescheduling of appointments and a HL7 V2 interface for the exchange of appointment data. The PathApp server was implemented in Java Script in a NodeJS environment on top of a MySQL database with a REST-API for interaction. The web interface for use by healthcare professionals was programmed in the React JS framework [10] on Microsoft IIS. The app for the patient himself was implemented in React Native. The HL7 V2 interface was realized using the rimiti hl7 object parser [11].

3. Results

The different student activities resulted in a functional prototype of the Patient Navigator App that is able to retrieve appointment data and to visualize the treatment path for the patient.

3.1. Interfaces and requirements

The interface analysis revealed the requirement to connect the app to 1) information systems at the general practitioner (e.g. using the Swiss GP communication standard SMEEX [12]), 2) to hospital IT applications using e.g. HL7 V2 messages and 3) to IT systems of rehabilitation centers using CDA-CH format. Sequence diagrams were designed to define appropriate transmissions and updates of rescheduled appointment dates.

16 persons (9 female, 7 male) aged between 60 and 80 participated in the survey. Use of modern communication technologies was rather high among the participants: 14 out of 16 (88%) use a smartphone daily, 2 use it on a weekly basis. 3 persons (19%) use additionally a tablet PC on a daily basis. Another 4 persons (25%) use a tablet PC every week. Based on the paper-based mockup of the patient navigator app, half of the participants confirmed such app to be very useful or useful. Most participants (12 / 75%) desired an organizer function. Additionally, they asked for reminder functions and checklist functions.

3.2. Competitive Search for a User interfaces

The competitive task of interface design resulted in three clearly different solutions for the patient's user frontend (Fig1). Following the collected feedback from potential users, a schedule-like version was selected as the most promising design (see Fig. 1, middle). This appointment visualization is similar to the app of the Swiss railway SBB showing the route of the train together with the time of arrival in a timeline. Since this SBB app is often used by Swiss inhabitants, the interface is well-known and self-explaining.

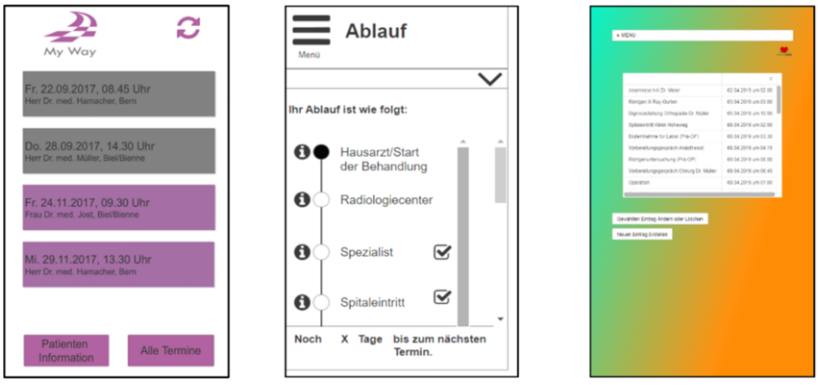

Figure 1. Three different user frontend designs developed in a competitive course.

3.3. Implementation

The prototype of the Patient Navigator App comprises four components. The first component is the Navigator App itself (fig 2 left side), intended for use by the patient on a mobile device, typically a smartphone. It presents an overview for all past and pending appointments including appointment details. Furthermore, checklists for single appointments can be added with items to be considered by the patient. Finally, the app provides an option to communicate with the healthcare providers and to ask for the rescheduling of a pending appointment. The second component is a central PathApp server which stores all appointment data of different patients. It can be connected to different IT systems in hospitals and GP practice to receive appointment updates and to transmit requests for appointment rescheduling and has been described in detail by Denecke et al. [7]. The third component is a web interface (fig 2, right side) for the physician or healthcare professional to lookup pending appointments for own patients, search for a specific patient, schedule new appointments for a particular patient, display patient rescheduling requests and reschedule appointments. In addition, the web interface supports the definition of checklists for an appointment. The web interface communicates directly with the PathApp server. The fourth component is an interface to the PathApp server which is able to process incoming HL7 V2 SIU messages for new appointments from e.g. a hospital information system.

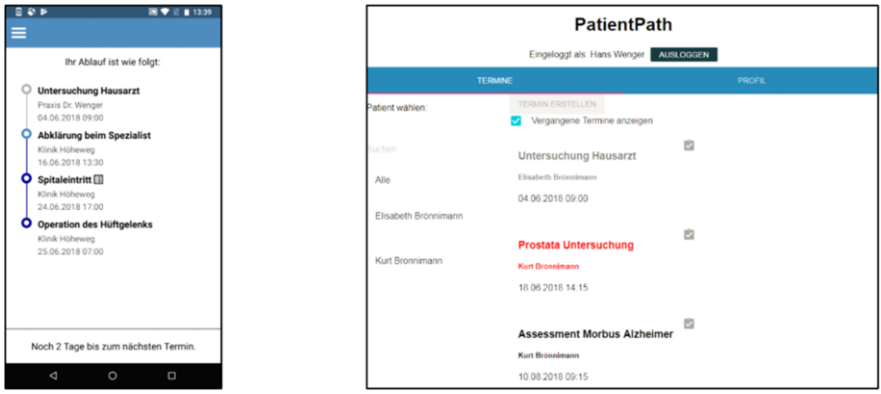

Figure 2. Lab prototype of patient navigator app. Left side shows the patient view on a mobile device. Grey past appointment, dark blue future appointments, light blue next appointment. Right side web interface for healthcare professionals. All appointments of own patients. Grey past appointment, red appointment where patient requested rescheduling, black future appointment (different patients).

It turned out to be difficult to establish a direct communication from information systems to the PathApp server. Even in the comprehensive laboratory environment with two installed GP information systems and more than three available clinical information systems from various manufacturers we could not establish direct communication. Manufacturers were contacted, but some of them completely declined the ability to export appointment data. Others presented proprietary interfaces, which, however, were not available within the systems implemented in our laboratory. One manufacturer declared to be able to communicate standard HL7 V2 SIU messages, but it turned out that this communication interface was not configured correctly.

4. Discussion

Clinical Pathways inside institutions [1-4] have their proven merits, although one could ask the question, why they are not more widely used in inpatient care [13]. There are few studies, which examine the additional value of software support for clinical pathway management [14]. Cross institutional clinical pathways are even more complex and often still under evaluation [15]. Therefore, the following summary has to be taken with caution, since a clinical evaluation of our development is still pending.

We do think, that the Patient Navigator App has the potential to improve interaction with healthcare professionals and offers a chance that more appointments can be better scheduled and attended. Appointments are more likely to be successful if all checklist items are completed by the patient. During inpatient stay, provision of pathway information for the patient can be a value added function of the respective healthcare institution. Thus, the app could contribute to patient satisfaction and patient empowerment.

Lessons learned:

- Elderly patients use modern information technology on a regular basis.
- They agree to use an app for trans-sectoral guidance through a healthcare episode.
- Patient requests for rescheduling should be supported.
- Competitive programming provided a minimalistic interface, which, according to potential users, was easy to use.
- To avoid additional workload for healthcare professionals, the app must be interfaced with the clinical systems acting as the master for appointment data.
- The resulting system architecture was more complex than expected and requires a dedicated Path App Server.
- None of five different clinical information systems could be timely interfaced.
- For interaction with the future Swiss Electronic Patient Dossier CDA formats for appointment data will be required.

Before we started our activities, we searched app stores and literature for comparable applications. We found several apps, e.g. a German app for hip TEP patients [16], but none which interfaced to clinical systems and was able to support rescheduling of appointments in a generic fashion. That, however, although technically demanding, has been highlighted as a desirable added value for a Patient Navigator App.

From other projects, we have information that a considerable number of outpatient appointments in hospital departments fail because the patient doesn't turn up. This causes loss of time for the healthcare professionals and expenditure for the institution. Although we implemented a dedicated web interface for healthcare professionals, we do not consider it a viable solution, due to the extra effort required to deal twice with appointment data. Instead, a direct information flow from clinical systems in GP practice and hospital to the Patient Navigator App is essential, maintaining the role of appointment master within the clinical IT systems. HL7 V2 offers a message based solution to transmit and alter appointment data and has been implemented as a first interface. It is typically used in inpatient environments. We could not identify a viable alternative for the many GP information systems available in Switzerland which currently do not support a common communication standard for appointment data. A master patient index is necessary to combine appointment data from different institutions for a single patient on the PathApp server.

From 2020, Swiss patients will be entitled to obtain an electronic health record (EPD) based on CDA and IHE xds.b profiles [17]. An MPI will then be available on a community level. Today, Swiss CDA level 3 appointment structures have not yet been defined and our next efforts will concentrate on this topic. It will remain an open issue if the Swiss EPD environment could then completely replace the current PathApp server in its functionality. This would offer the advantage that clinical systems shall be anyway interfaced to the EPD.

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